# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS
## 2021/2022 ACADEMIC YEAR

### SECOND YEAR FIRST SEMESTER
### MAIN EXAMINATIONS

FOR THE DEGREE OF BED (SCIENCE)

**COURSE CODE:** SPH 211

**COURSE TITLE:** WAVES AND OSCILLATIONS

**DATE:** 25/01/2022 **TIME:** 2-4PM

**INSTRUCTIONS TO CANDIDATES**

TIME: 2 Hours

**Answer question ONE and any TWO of the remaining**

## QUESTION ONE (30 marks) compulsory

(a) Define the following terms:

- (i) Wavelength (1mk)
- (ii) Amplitude (1mk)
- (iii) Time period (1mk)

(b) Distinguish between transverse and longitudinal wave motions (2mks)

(c) Briefly discuss the three types of velocities in wave motion (6mks)

(d) Show that the discharge of a condenser through the following inductive circuit is oscillatory hence calculate its frequency. $C = \mu F$, $L = 10mH$ and $R = 200\Omega$ (8mks)

(e) Define normal mode of vibration and state its importance (2mks)

(f) State the characteristics of wave motion (4mks)

(g) Consider a body executing simple harmonic motion through a small displacement x from its equilibrium position, show that the equation of simple harmonic motion is given by:

$$\ddot{x} + \omega^2 x = 0$$ (5mks)

## QUESTION TWO (20 marks)

(a) Consider a mechanical oscillator of mass, m, stiffness, k and resistance, r being driven by an alternating force, $F_0 \cos \omega t$, show that the displacement, x, of the oscillator is given by:

$$x = \frac{-iF_0 e^{i(\omega t - \phi)}}{\omega Z_m}$$ hence discuss its solution (16mks)

(b) State any three information from the steady state behavior of displacement x of a forced oscillator. (3mks)

(c) State the voltage equation in the electrical case of forced oscillatory motion (1mk)

## QUESTION THREE (20 marks)

(a) The equation of displacement of a point on a damped oscillator is given by:

$$x = 5e^{-0.25t} \sin(\frac{\pi}{2})t$$

Determine the velocity of the oscillating point at $t = \frac{T}{4}$ and T where T is the time period of the oscillator. (13mks)

(b) Consider two simple harmonic motions given by:

$$x_1 = a_1 \cos(\omega t + \phi_1) \text{ and}$$

$$x_2 = a_1 \cos(\omega t + \phi_2)$$

Obtain the resulting displacement of the two motions (7mks)

## QUESTION FOUR (20 marks)

(a) Show that the kinetic energy of a vibrating particle is given by:

Average kinetic energy $= \pi^2 m a^2 n^2$

Where m is the mass of the vibrating particle, a is the amplitude of vibration and n is the frequency of the vibration. (12mks)

(b) A particle executes simple harmonic motion given by the equation:

$$y = 12\sin(\frac{2\pi t}{10} + \frac{\pi}{4})$$

Determine the amplitude, frequency and displacement at t = 1.25s. (8mks)

## QUESTION FIVE (20 marks)

(a) State the condition for each of the following:

i) Heavy damping (1mk)

ii) Critical damping (1mk)

iii) Light damping (1mk)

(b) Consider the motion of an element of the gas of thickness $\Delta x$ and unit cross-section under the influence of a sound wave. The particles in the layer x are displaced a distance $\eta$ and those at $x + \Delta x$ are displaced a distance $\eta + \Delta \eta$, show that:

$$\frac{\partial^2 \eta}{\partial x^2} = \frac{1}{C^2}\frac{\partial^2 \eta}{\partial t^2}$$ (15mks)

(c) State any two properties of electromagnetic waves (2mks)